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(54) A method of forming a multilayer plastic pipe and a multilayer plastic pipe for conducting fluids.

(57) According to the invention, a core pipe (2) is formed, whose properties correspond to the requirements set by the fluid to be conducted. With a suitable coating method an outer protective layer (3) is formed around the core pipe (2) of such a plastic material, which properties meet the requirements set by the prevailing environment and/or pipelaying procedure.

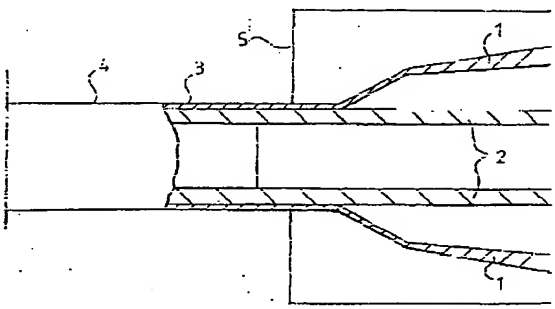

FIG. 1

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The invention relates to a method of forming a multi-layer plastic pipe for conducting fluids. The invention also relates to a multi-layer plastic pipe formed by the method, as well as to a method of connecting a multi-layer plastic pipe.

During handling, laying and joining of plastic pipes, the pipe surface is exposed to damage. For example, modern laying methods for plastic pipes are based on drilling a tunnel in the ground for the pipe, the pipe being then passed through the tunnel e.g. to an excavation where the next pipe sections are seamed.

Naturally, a pipe is hereby subjected e.g. to different bending and tensile forces. This is disadvantageous since bending, stretching and scratching of a pipe deteriorate its mechanical strength, thereby reducing its life. In addition, the lifetime of a pipe may be reduced by environmental condition, such as diffusible materials.

It is previously known to coat plastic pipes with different protective layers e.g. for transportation and storage. However the known protective layers are not load carrying structures, neither in respect of mechanical nor chemical loads.

The object of the present invention is to eliminate the above disadvantages by providing a method for forming a dual layer plastic pipe. It is also an object of the present invention to provide such a pipe. Furthermore, it is an object of the present invention to provide a method of connecting a dual layer plastic pipe. A pipe according to the present invention is is easy to lay and, in addition, inexpensive in view of its properties.

The method of forming a two-layer plastic pipe for conduction fluids, the two-layer plastic pipe formed by the method, and the method of connecting a dual layer plastic pipe, are characterized by what is stated in the appending claims.

A pipe according to the present invention, which is provided with a protective layer, is stiffer and stronger than the corresponding pipes in general and, in addition, it is fully protected against scratching. The invention enables e.g. the use of standard pipes in conditions to which they are not applicable as such, e.g. in laying procedures that cause vast tensile stresses or in laying in the ground pipes impervious only to internal pressure.

When a single-layer pipe is formed, often a bigger or smaller amount of fillers, depending on the use or the pipe must be fixed with the plastic materail. Fillers usually have a disadvantageous effect on the mechanical properties and weldability of the pipe. In a two-layer pipe according to the present invention, the properties of the core pipe or conducting pipe are optimised for the conducting of fluids and the outer layer is designed to resist any external conditions and stress. This results in a pipe arrangement where the structure has not been compromised with, thus replacing expensive special pipes with standard pipes coated with an inexpensive outer layer tailored for the laying conditions.

Welding is also easier and safer with the pipe formed by the method of the invention since e.g. seaming of pipes is not possible without that the outer layer is first removed from the area to be seamed, i.e. the pipe ends must always be clean when they are seamed, whether by welding or by any other method. The inventive concept ensures that welding is always successful and that the welding machines operate as intended.

In the following the invention is described in greater detail by means of examples and with reference to the attached drawings, wherein

Fig. 1 depicts a forming method and a pipe according to one embodiment of the invention,

Fig. 2 depicts another embodiment of the pipe of the invention.

Fig. 3 shows partly in section two pipes according to the invention placed in a welding device.

Fig. 1 depicts coating of a plastic pipe 2 according to the invention with a surface layer by coextrusion. The surface layer is formed from melt plastic 1 to provide a protective layer 3 around a pipe 2 of a specified size. Coextrusion dies 5, e.g. so-called crosshead dies, are known to one skilled in the art, and coextrusion as such is not explained herein in greater detail.

The protective outer layer according to the invention is advantageously made easily detachable from the core pipe by simple means, either wholly or only at the joint surfaces, such as the pipe ends. In this way, the surfaces remain in as good a condition as possible for the seaming carried out by e.g. welding. According to a preferred embodiment of the invention, these objectives are achieved by making the surface of the outer layer moderately hard, whereby it has a low adhesion, and to make the structure of the layer moderately stiff, whereby the outer layer con be detached from the pipe e.g. by knocking. For example chalk and talc are suitable fillers in respect of achieving this effect.

In a pipe 4 according to the invention the plastics raw material used for the protective outer layer 3 may be e.g. linear LDPE or even recycled plastics waste. The advantage of the linear LDPE is its high scratching and puncture resistance in view of its price, whereas the advantage of the plastics waste is its low price. When the material is selected, it is advisable to take into account that if the outer layer is made from plastics differing from the material of the core pipe with respect to the chemical structure, the adhesion between the pipe and the protective outer layer is probably lower (they can be detached more easily) than if exactly the

same material is used.

According to another preferred embodiment of the invention, the material of the outer layer 3 has at least the same strength and/or stiffness as the material of the core pipe 2. Thus the protective outer layer can be a load-carrying component without having high requirements set for the raw material (the price must be as low as possible). Thus, cheap reinforcing and/or stiffening fillers or fibres may be mixed to the material of the protective layer. Alternatively, an outer layer 7 may be stiffened in accordance with Fig. 2, by ribbing or corrugations 6, to make the pipe 8 sufficiently stiff. The ribbed outer layer 7 may be formed e.g. in a gilled pipe machine or corrugating device.

The protective outer layer can also be stiffened by foaming in a forming step, whereby the pipe also acquires a considerable thermal insulation capacity.

Furthermore, the material of the outer layer 3 may advantageously be crosslinked in order to improve the stiffness and strength and the resistance of the outer layer of the pipe. In pipes reinforced in this manner, the core pipe may be a thin-walled pipe or even a hose, which is capable of resisting only internal pressure caused by the fluid to be conducted, but which would be flattened by earth pressure when laid in the ground it not properly supported. The strength properties of the outer layer may also be made different in the radial and axial directions of the pipe.

In a further embodiment of the invention, slate-like mica is mixed with the material of the outer layer to improve the barrier properties of the pipe. For example, benzene compounds penetrate fairly easily through a wall of a conventional tap water pipe made from polyethene. When a mixture having good resistance (barrier properties) to the penetration of the above substances is selected as the material of the outer layer, it is easy to tailor a tap water pipe for a specified aggressive chemical environment.

In yet another embodiment of the invention barium sulfate is mixed with the material of the outer layer to make the specific gravity of the pipe higher than that of water. Barium sulfate($BaSO_4$) has a high density, wherefore the overall density of e.g. a polyethene pipe can be made higher than that of water. This feature makes the pipe suitable for arrangements where the pipe is laid in water.

In an additional embodiment of the invention, easily magnetizable material or electrically conductive particles are mixed with the material of the outer layer to render the pipe detectable by a magnetic field. Examples of magnetizable material are iron oxide and barium ferrite. In this embodiment the outer layer makes it possible to render the pipe laid in the ground easily detectable by electromagnetic means. Mixed in a single-layer pipe, fillers of this kind would reduce the strength of the pipe.

In still a further embodiment of the invention, electrically conductive material is mixed with the material of the outer layer to render the pipe electrically conductive. In an electrically conductive outer layer, cracks occurring in the pipe line can be detected e.g. by a cable fault finder. In addition, an electrically conductive outer casing eliminates risks caused by induced electricity e.g. in a explosive environment. The electrically conductive material may also be e.g. a copper wire embedded in the outer layer.

In a still further embodiment of the invention all the necessary identifying dyes and UV stabilizing agents are mixed with the material of the outer layer. Thereby these pipe material-weakening agents need not be mixed to the material of the actual conducting or core pipe 2.

During the formation of the pipe it is possible to introduce an adhesion inhibiting or enhancing agent, depending on the use and the materials selected, between the outer layer and the core pipe. In a preferred embodiment of the invention, a release agent, such as a low molecule weight polyethylene wax, is mixed with the material of the outer layer to facilitate the detachment of the outer layer from the core pipe 2. In another layer dipped in a bath containing liquid polymers which act as an adhesion inhibiting layer.

If the core pipe is made e.g. from polyethene and the outer layer from polypropene mixed with wax, the outer layer is easy to detach from the core pipe. This is particularly advantageous when the core pipe needs to be easily replaceable (relining): the core pipe is replaced by simply pulling it out from the outer layer and inserting a new core pipe in the layer formed by the outer layer.

The outer layer can also be designed to be detachable from the core pipe upon applying heat to the part of the outer layer to be removed.

It is also possible to introduce welding and/or crosslinking enhancing agents between the outer layer and the core pipe. Suitable welding enhancing agents include e.g. dicumylperoxide. Crosslinking agents complement the crosslinking reaction of the pipe material in the joint surface and provide lubrication, which is advantageous in that it reduces the adhesion of the protective layer. The crosslinking agents may be the same generally known radicals that are used in the matrix material of the pipe.

In a further embodiment of the invention, a thin aluminum layer is provided between the outer layer and the core pipe. The aluminum layer both facilitates the detaching of the outer layer (in contrast to known plastic aluminum laminates) and functions

as a barrier layer. In practice, a thin (0.1-0.3 mm) aluminum folic is formed on the outer layer of the core pipe by adhesion or ultrasonic welding.

A pipe according to the present invention is advantageously seamed by peeling the outer layer off at the area of the pipes to be seamed, and by subsequently placing the pipes to be seamed together, and by carrying out the seaming e.g. by electric welding. Thereafter the seam is protected where necessary with a layer similar to the outer layer, or left unprotected. In figure 3 is shown, by way of example, two, identical pipes 9 according to the invention, which are placed with their ends positioned against each other at 10 in an electrofusion pipe coupler device 11. The outer layers 12 of the pipes has been removed from the cores 13 at the ends of the pipes 9, in order to facilitate proper insertion and welding of the pipes.

It is obvious to one skilled in the art that the embodiments of the invention are not limited to those described above, but that they may vary within the scope of the attached claims.

Claims

1. A method of forming a multi-layer plastic pipe (4;8) for conducting fluids, **characterised** by forming at least a core pipe (2), whose properties correspond to the requirements set by the fluid to be conducted, and by forming with a suitable coating method an outer protective layer (3;7) around the core pipe (2) of such a plastic material which properties meet the requirements set by the prevailing environment and/or pipelaying procedure.

2. A method according to claim 1, **characterised** in that the outer layer (3) is provided around the core pipe (2) by coextrusion in such a way as to be easily removable from a desired section of the pipe.

3. A method according to claim 1 or 2, **characterised** in that slate-like mica is mixed with the material or the outer layer (3) to improve the barrier properties of the pipe.

4. A method according to claim 1, 2, or 3, **characterised** in that reinforced fibre is mixed with the material of the outer layer (3) to improve the strength properties of the pipe.

5. A method according to any one of claims 1 to 4, **characterised** in that barium sulfate is mixed with the material of the outer layer (3) to make the specific gravity of the pipe higher than that of water.

6. A method according to any one of claims 1 to 5, **characterised** in that easily magnetizable material or electrically, conductive particles are mixed with the material of the outer layer (3) to render the pipe detectable by a magnetic field.

7. A method according to any one of claims 1 to 5, **characterised** in that electrically conductive material is mixed with the material of the outer layer (3) to render the pipe electrically conductive.

8. A method according to any one of claims 1 to 7, **characterised** in that flanges or corrugations (6) spaced from one another are provided on the outer layer (7) to improve the stiffness of the pipe (8).

9. A method according to any one of claims 1 to 8, **characterised** in that the material of the outer layer (3) is foamed to improve the stiffness and/or thermal insulation capacity of the pipe.

10. A method according to any one of claims 1 to 8, **characterised** in that the material of the outer layer (3) is crosslinked to improve the stiffness and strength of the pipe.

11. A method according to any one of claims 1 to 10, **characterised** in that the identifying colouring agents and UV stabilising agents for the whole pipe (4;8) are included in the material of the outer protective layer (3;7).

12. A method according to any one of claims 1 to 11, **characterised** in that a release agent such as wax, is mixed with the material of the outer layer (3) to facilitate the detachment of the outer layer from the core pipe (2).

13. A method according to any one of claims 1 to 11, **characterised** in that a release agent, such as wax, is added between the core pipe (2) and the outer layer (3) to facilitate the detachment of the outer layer from the core pipe (2).

14. A method according to any one of claims 1 to 11, **characterised** in that a thin aluminium layer is provided between the outer layer (3) and the core pipe (2) to facilitate the detachment of the outer layer (3) from the core pipe (2) and to improve the barrier properties of the pipe.

15. A multi-layer plastic pipe (4;8) for conducting fluids, **characterised** by at least a core pipe

(2) whose properties correspond to the requirements set by the fluid to be conducted, and by an outer protective layer (3;7) provided around the core pipe of such a plastic material which properties meet the requirements set by the prevailing environment and/or pipelaying procedure.

16. A pipe according to claim 15, **characterised** in that the outer layer (3) is provided around the core pipe (2) in such a way as to be easily to removable at a desired section of the pipe.

17. A pipe according to claim 15 or 16, **characterised** in that the outer layer (3) contains slate-like mica.

18. A pipe according to claims 15, 16 or 17, **characterised** in that the outer layer (3) contains reinforced fibre.

19. A pipe according to any one of claims 15 to 18, **characterised** in that the outer layer (3) contains barium sulfate.

20. A pipe according to any one of claims 15 to 19, **characterised** in that the outer layer (3) contains electrically conductive particles or easily magnetizable material.

21. A pipe according to any one of claims 15 to 19, **characterised** in that the outer layer (3) contains electrically conductive material.

22. A pipe according to any one of claims 15 to 21, **characterised** in that the outer layer (7) comprises flanges or corrugations (6) spaced form one another.

23. A pipe according to any one of claims 15 to 21, **characterised** in that the outer layer (3) is foamed.

24. A pipe according to any one of claims 15 to 23, **characterised** in that the outer layer (3) is of crosslinked material.

25. A pipe according to any one of claims 15 to 24 **characterised** in that the identifying colouring agents and UV stabilising agents for the whole pipe (4;8) are included in the material of the outer protective layer (3;7).

26. A pipe according to any one of claims 15 to 25, **characterised** in that the outer layer (3) contains a release agent, such as wax.

27. A pipe according to any one of claims 15 to 25, **characterised** in that it contains a layer of release agent, such as wax, between the core pipe (2) and the outer layer (3).

28. A pipe according to any one of claims 15 to 25, **characterised** by a thin aluminum layer between the outer layer (3) and the core pipe (2).

29. A method of connecting a multi-layer plastic pipe (9) comprising at least an inner core (13) and an outer protective layer (12), **characterised** in that a region of the outer layer (12) is removed to expose the inner core (13), and that a connection to the exposed core (13) is made using an electrofusion welding device (11).

30. A method according to Claim 29, **characterised** in that the inner core (13) and the outer layer (12) are co-extruded.

31. A method according to Claim 29 or 30, **characterised** in that the adhesion between the inner core (13) and the outer layer (12) is such that the outer layer can be peeled away from the inner core.

32. A method according to any of Claims 29 to 31, **characterised** in that the inner core (13) is a polyethylene pipe.

33. A method according to any of Claims 29 to 32, **characterised** in that the outer layer (12) is a low density polyethylene layer.

34. A method according to any of Claims 29 to 33, **characterised** in that the region to be removed is at an end of the pipe (9).

35. A method according to any of Claims 29 to 34, **characterised** in that the electrofusion welding device is an electrofusion pipe coupler (11).

36. A method according to Claim 35, **characterised** in that the outside diameter of the end of the dual layer pipe (9) is greater than the diameter of the socket of the coupler (11), so that the outer layer (12) has to be removed before the inner core (13) can be inserted into the coupler (11).

37. An electrofusion joint, **characterised** in that it has been made using a method according to any of Claims 29 to 36.

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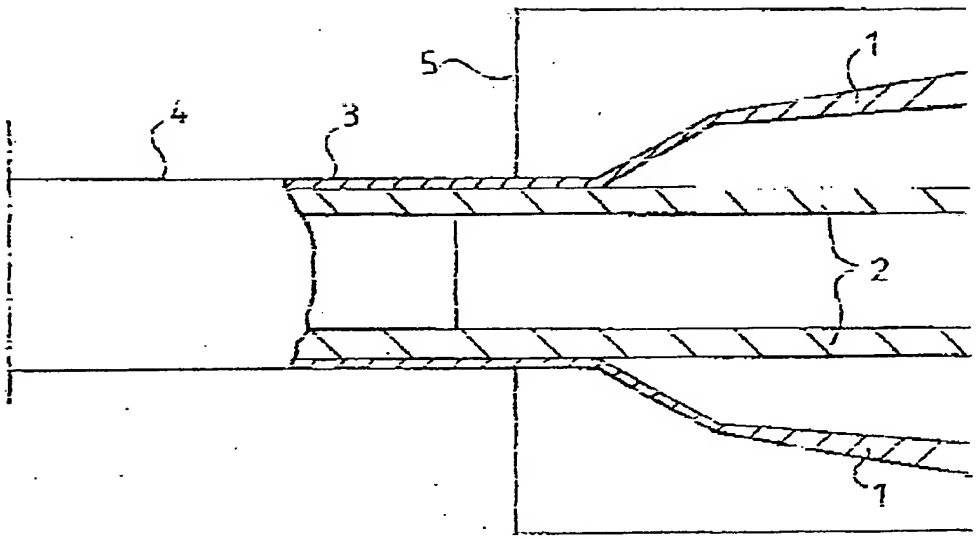

FIG. 1

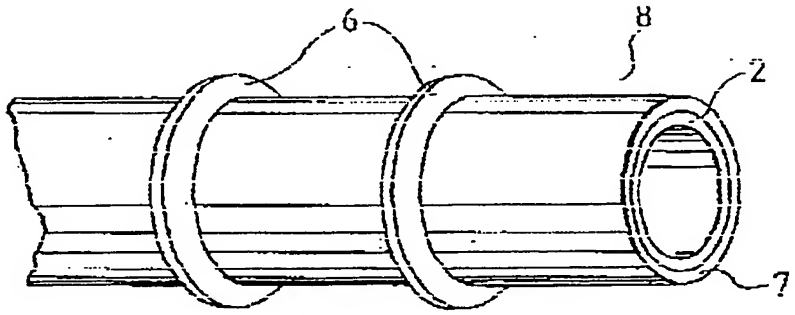

FIG. 2

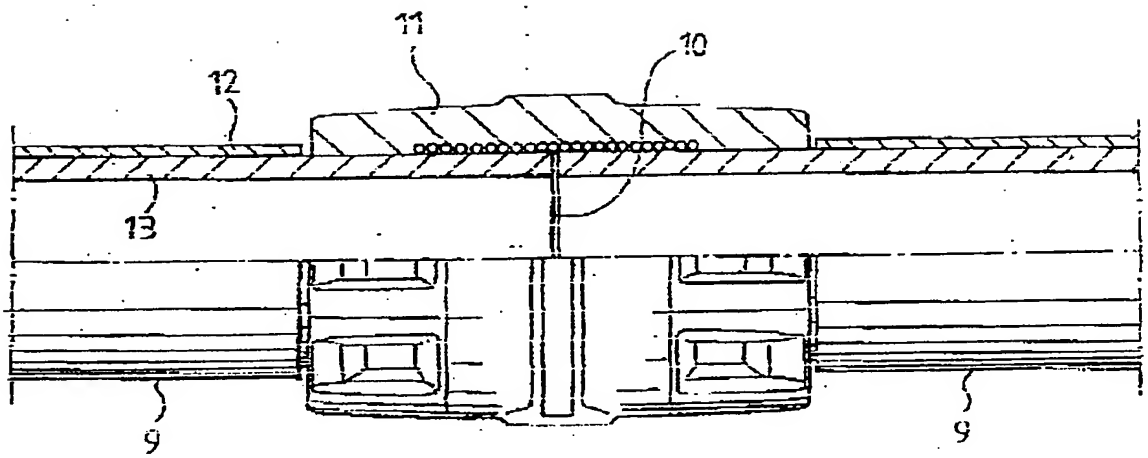

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number EP 93120793.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	AT - B - 0 365 974 (ALLGEMEINE SYNTHETISCHE GESELLSCHAFT) * Totality * --	1,2,4	B 29 C 47/06 B 29 C 65/34 F 16 L 9/14
X	US - A - 3 649 730 (BENTELER) * Claim 1; fig. 3 *	1,2,9	
Y	* Claim 1; fig. 3 * --	3,14	
X	EP - A - 0 024 220 (OLLIVIER) * Fig. 2 *	1,2	
A	* Fig. 2 * --	14	
Y	EP - A - 0 159 307 (KABEL- UND GUMMIWERKE) * Claim 1 * --	14	
Y	US - A - 4 932 746 (CALZOLARI) * Claim 9 * --	3	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
X	WO - A - 91/00 466 (JONA CO) * Totality * --	15,18	B 29 C F 16 L G 02 B
X	DE - A - 3 638 136 (KABEL- UND METALLWERKE GUTEHOFFNUNGSHÜTTE) * Totality * --	15,20	
X	AT - B - 0 385 104 (WIELAND-WERKE) * Totality * --	15,22	
X	AT - B - 0 351 324 (KABEL- UND METALLWERKE GUTEHOFFNUNGSHÜTTE) * Totality *	15,23	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	25-02-1994	REININGER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE - A - 3 016 134 (MECANO-BUNDY) * Totality *	15,28	
X	US - A - 4 906 313 (HILL) * Totality *	29-37	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

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